



Knowledge networks, nodes and new organisational forms

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Abstract

Science has a matrix of research 'space' and 'fields'. Research space is a virtual environment comprising knowledge producers, users, funders and policy makers. Research 'fields' enclose the cognitive architectonic of science and cut across organisational and disciplinary boundaries.

Research fields and space can be conceived of as in a matrix relationship. Fluidity between space and fields offers the prospect of the creation of new organisational forms which escape the neoliberalisation of science. We argue that university science might best be performed as part of open systems of innovation, in which innovative organisations work in ongoing partnerships to share knowledge in such a way as to generate sustainable streams of innovation.

Open innovation practices require that attention is paid to the forms of governance, ownership and management that would be suitable for the various organisations that might populate such processes. It can be assumed that existing forms of governance, ownership and management might not necessarily be suitable, especially if they are predicated on conceptions such as market competition, arms-length relationships and commercial confidentiality - the types of organisational forms that the UK government has promoted for publicly funded science for some years. Recent innovation research identifies the importance of a variety of forms of networks as being central to sustaining the innovation process.

In this paper we extend notions of open innovation systems and consider whether knowledge production might be moved away from the privatised, commercialised, competitive pressures towards an open, collaborative and cooperative process.

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The sciences are dynamic knowledge seeking/producing activities that have always been framed by their social and economic contexts. Notions of and discussion about of how the sciences are or should be ‘organised’, that is, formed, arranged and disposed across space and time – their virtual and actual geographies – are far from new. We construe ‘organisation’ in this context broadly. That is, whilst universities, which form the main focus of this paper, are ‘organisations’ they also exist as actors within the wider organisation of science.

Current obsessions amongst governments, particularly in richer countries, are that the organisational forms of the sciences should be optimised for the promotion of economic development and growth; that is, science is a knowledge activity essential to the so-called ‘knowledge economy’ or knowledge societies’. In neoliberal regimes in particular, this has led to attempts to determine and direct scientific knowledge formation, access and distribution. In the UK, and indeed globally, this has impacted severely on universities, with these institutions becoming increasingly corporatised and marketised (Epstein et al 2007).

In this paper we describe and critique the transition of UK publicly funded science from one organisational form to another and chart the impact of this on universities. We then present a normative model of how the problems caused by this migration might be attenuated by the adoption of a radically new organisational form for the sciences. We are hopeful that this new model would be beneficial to universities, enabling them to recuperate something of their traditional role as producers of open access fundamental knowledge for the benefit of both the economy and civil society.

Accordingly, this paper is organised in three principal parts. In the first we develop and explain some concepts that we believe are useful in understanding the organisation of science. In the second we explain the transition in organisational forms which science has undergone in the UK. In the third and final section we present a new, normative model for scientific organisation that, we feel, meets many of the objections of the current regimes.

1 Conceptualising the organisation of sciences and knowledges

The sciences are a set of socially, politically and economically determined activities that result in the production of knowledge. The organisation (in the broad sense) of the sciences will, therefore, impact upon the nature of the knowledges produced. A concept we find useful for conceptualising the role of organisational factors in the relationship between the sciences and the knowledges they produce is that of ‘knowledge pools’.

We define ‘knowledge pools’ as the ‘bodies of knowledges’ generated by scientific activities that can, but do not necessarily, constitute socio-economic resources capable of exploitation (that is, usable knowledge). Knowledge pools can be thought of as a bit like natural lakes or reservoirs, which have streams flowing into them and valleys or dams to contain them. Water egresses either naturally or through regulating devices such as valves or pipes. In the real world of physical geography these bodies of water are either open access for the purposes of exploitation (e.g. for fishing, power or irrigation) or are privately owned and controlled. The arrangement or organisation of the physical features that produce inflows and outflows may be the result of varying degrees of human intervention. The ‘organisation’ of such bodies of water obviously impacts on their essential physical and ecological characteristics – the water in an entirely natural lake that flows freely into the sea will be very different from that retained in an artificial reservoir used for drinking water.

Whilst the organisation of lakes and reservoirs is a matter of physical geographies and civil engineering, knowledge pools are somewhat more subtly and socially constructed. The organisational attributes will be the product of the imperatives that drive the scientific processes that generate inflows and the access rights and capacities of knowledge ‘users’. If bodies of knowledge are analogous to such bodies of water, then it follows that the organisational arrangements made for the flow of knowledges into pools and the use made of them will impact upon the characteristics and ecology of the knowledges they contain.

Stokes (1997) provides a useful way of conceptualising the imperatives of and demands on knowledge producers. His starting point was the ‘compact’ between science and the US government after World War Two, which embodied a linear notion of the production of a constant stream of basic science knowledge that would lead, seamlessly to applied knowledge and thence technological innovation. This compact emphasized that “the creativity of basic science would be lost if it is constrained by premature thought of practical use” (Stokes, 1997: 3).

Stokes sought to escape this linear model by adapting Pasteur’s Quadrant. This is a matrix that juxtaposes whether there is a quest for fundamental understanding against considerations of the use of the knowledge so produced. The model is shown in Table 1.

		Considerations of use?	
		No	Yes
Quest for fundamental understanding?	Yes	Pure basic research (e.g. Niels Bohr)	Use-inspired basic research (e.g. Louis Pasteur)
	No	‡	Pure applied research (e.g. Thomas Edison)

‡ Even though Stokes did not suggest any specific name for the lower left-hand cell, he emphasizes that it is not empty.

Table 1: Pasteur's Quadrant (Source: Stokes, 1997, 73)

We find this characterisation useful in considering the imperatives experienced by those who contribute to knowledge pools and, allied to these, the demands exerted by those who utilise them. In particular, we argue in this paper, factors such as funding, the institutional conditions of knowledge production and use conditions drive knowledge producers to particular points of this matrix and that this consequently impacts upon the characteristics of knowledge pools. Funding is essential as it facilitates knowledge production and can also be used to overtly direct the organisation of science. By the institutional conditions of knowledge production we mean the particular characteristics and shape of the institutions within which knowledge production occurs. For instance, an institution that rewards staff for blue skies creativity over, say, income generation will produce very distinctive types of knowledge. And finally, the access rights and power of knowledge users will interact with funding and production conditions – that is, demand may shape supply through such means as funding and policy choices.

In understanding how the sciences respond to these imperatives and demands we utilise the notions of research spaces and fields. We conceptualise science as being framed by a matrix of research 'space' and 'fields'. Research space is a virtual environment comprising scientific knowledge producers, users, funders and policy makers. The interactions between these actors shape its core characteristics. Research fields comprise epistemic communities that are clustered around converging knowledge pools (see for example Whitley 2000; Böhme et al 1983; Stankiewicz 2002; Stokes 1997; Bonaccorsi 2005). Epistemic communities are social networks that cut across organisational and national boundaries. Through a variety of heterogeneous social relations they re-produce cognitive understandings. Participants in epistemic communities are also part of organisations in the research space and depend upon these for funding and other resources, and facilitation of their research work. Therefore imperatives and pressures for change on organisations within the research space will inevitably have consequential but non-uniform impacts on epistemic communities and, hence, cognitive understandings produced within the research field. This has a consequential impact on what flows into knowledge pools.

In the next section we describe the process of change that has been occurring to the character and nature of knowledge pools.

2 The changing organisation of the sciences

Traditional science

Until comparatively recently, the dominant conceptualisation of science, grounded in structural-functionalist epistemic assumptions, was of a set of practices that constituted a unique and self-organising domain of social production and hence should be autonomous. Science therefore existed within 'the sphere of human activities' identified as the independent 'Republic of Science' by Dasgupta and David (1994: 487, following Polanyi 1962).

Merton (1973) characterised science as having the function of producing

codifiable open knowledge that might be economically beneficial, have some general civilising, effect or be useful in government. In return for this knowledge, scientists receive specific rewards unrelated to the economic usefulness of the knowledge.

(Baskaran and Boden 2007)

Writing in 1969, Stephen and Hilary Rose said

Science is... maintained by a value system which emphasises universality and disciplinary communism and a reward system whereby the scientist, in return for the gift of knowledge to his (*sic*) readers, is accorded status and recognition.

(Rose and Rose 1969: 8).

Under such traditional visions of science, British universities were important sites of independent scientific knowledge production. The research space in the UK primarily comprised the universities and the government, but the government construed its position in that space in a very particular way. Thus from the end of the First World War, British governments generously supported British universities. The University Grants Committee (UGC), established in 1919 to reflect the Haldane principle that state funding of universities should not lead to state control over their activities, distributed state funds in the form of block grants research and teaching in an undifferentiated and non-selective way. The decision-making body of the UGC comprised only academics (Nedeva and Boden 2006).

In accordance with Mertonian principles of scientific endeavour, expectations of universities at this time were that they would concentrate on seeking fundamental understandings. Engagement with users was not encouraged, for fear it would adversely affect consideration of 'profound scientific questions' (Monbiot 2001, 283). The location of universities within the Independent Republic and the associated expectations of fundamental knowledge seeking meant that those who funded science (principally government) made no effort to control or direct it. University science, and indeed science in general, occupied a particular social position which placed it outside the commercial or industrial realm (Baskaran and Boden 2007). This created a distinct separation between scientific knowledge production and its ultimate use/consumption.

The scientific knowledge produced was part of a gift economy – it flowed freely into knowledge pools and exploitation was restricted only by the ability to access it in libraries and to understand it. Scientific knowledges were then public or merit goods. Public goods are freely available and their value is not diminished by usage. Merit goods are brought into existence not because of some consumer demand expressed through the market but because someone (usually government) has taken the decision that they are simply good things for society to benefit from. State supply and allocation of funding of this scientific knowledge creation was justified in terms of the uncertainty attached to

whether there would be financial returns for investment in scientific research and the difficulty of allocating returns because of the open nature of scientific practice (Nelson 1959; Arrow 1962). Scientific knowledge production was therefore characterised as being subject to ‘market failure’ (Dasgupta and David 1994) and therefore rightly outside of the commercial realm.

Universities then, during this phase, were the dominant contributors to knowledge pools. Their task was to independently produce, codify, verify and thereby determine the scientific knowledges that flowed into these pools. They did this through the medium of disciplinary associations, academic journals, conferences and such like. They produced public and merit goods rather than knowledges in response to market demands. Thus the research fields that converged around knowledge pools, pushing their development, were the products of the particular research spaces – spaces largely untouched by commercial or economic pressures and characterised by Mertonian notions of what science was. Consequently, the knowledge produced by universities was more of the ‘fundamental understanding’ type than user driven.

Pressures for change

During the ‘traditional’ phase of science, UK publicly funded science was characterised by gradual and endogenously generated organic development. This is unsurprising given the ‘hands-off’ approach taken by funders and others in the research space. That is, there were no external pressures for change.

Since 1979 however, UK publicly funded science has been radically revisioned by successive governments as an activity that *must* support the development of the economy. In contradistinction to the traditional phase therefore, the practice, institutions and culture are now subject to exogenous, policy-driven change pressures from government to contribute more directly and effectively to UK economic competitiveness (Boden, Cox and Nedeva 2006; Nedeva and Boden 2006).

The policy agendas of the Conservative regimes of 1979-97 were carried by a distinct political ideology. This evinced the state was inherently and fundamentally inefficient and that it could and should be reduced to the absolute minimum feasible size with its functions replaced by the rigour and disciplines of the free market. Those functions that remained should be only those necessary to support the functioning of the free market economy.

From the 1980s onwards, this ideology was applied with some vigour to publicly funded science (Boden et al 2004). A particular critique of UK scientific research coming from industry and the political Right was that it was remote from and unsupportive of UK economic efforts. The state of science and its economic contribution became one of the rationales for faltering levels of innovation and growth under a political ideology which could see no harm or fault with the free market. That is, science was failing the market and needed to be changed. The UK was producing the ‘wrong’ sort of scientific knowledge – too far from market and of no immediate commercial applicability. Understanding-type knowledge was, distinctly, off the menu.

This re-visioning of science as a user-led activity in support of the ‘knowledge economy’ was operationalised through the overt use of funding mechanisms as levers of control: funding for research was based on measures of productivity through the research assessment exercise and a general squeeze on state funding for the sector (Edgerton and Hughes 1987; Baskaran and Boden 2007). Relations between publicly funded science organisations and government/society are now largely configured through customer-contractor relationships with an emphasis on financial accountability.

These reforms reflect a re-visioning of science as an activity that should be economically useful, allied to the market and accountable for the efficient use of resources (Rappert 1995). This amounted to a significant discursive shift from previous conceptualisations of science as a public good and a necessary expenditure in a gift economy in which scientists give the gift of knowledge in exchange for non-interventionist public support.

Whilst appearing superficially quite similar, successive Labour governments since 1997 have followed an even more fundamentalist neoliberal ideological path. In contrast to the more classical liberalism of the Thatcher regimes, neoliberal governmental practice is not about containing the state in order to allow economic rationality to flourish unfettered. Rather, the neoliberal state seeks to *extend* its role, utilising a plethora of disciplinary and regulatory regimes to mould organisations and individuals into activity that shapes and sustains economic development in partnership with the market (Dean 1999; Rose 1996).

Consequently, knowledges and sites of their production become subject to struggle for ownership or control. Such struggles are not limited to intellectual property rights – the right to exploit knowledge pools. Control over the codification of knowledge, that is, the ability to determine what counts as valid knowledge, is also crucial. Moreover, the sustaining discourses constitutive of neoliberal regimes are dependent upon what Appadurai calls the ‘research imagination’ (Appadurai 2001). That is, control of what and how we think is key to the neoliberal endeavour.

Such economic thinking provides an entirely different conceptualisation of science, one founded on notions of science as an activity that supports and sustains the knowledge economy, a commodity, a capital base that requires a return on investments made. It follows therefore that science must be incorporated within the neoliberal state’s regime of practice rather than standing alone as a Mertonian exclusive and self-regulating domain.

The consequences of change pressures for knowledge pools

The re-visioning of science in the UK as an activity that must directly and demonstrably support economic competitiveness and growth had immediate consequences in the research space of UK science. In particular, universities lost their position in the ‘Independent Republic’ of science. Government became more proactive within the research space and, principally through financial mechanisms, subjected universities to ‘hands-on’ steering and control defined by systematic selectivity, competition and accountability (see for example Shattock 2003).

The funding regime changes led inexorably to changes in the conditions of knowledge production. Nedeva (2007) argues that the emergence of the ‘Third Mission’ of English

universities – an imperative exhortation for universities to work in close alliance with the private sector – was such a shift. She argues that the emergence of the Third Mission as a concept marked a shift from universities treating such activities as a function (i.e. building open knowledge pools) that they had almost always been engaged in, to a relational concept under which they were required to place themselves in particular and economically-driven and determined relationships with knowledge users.

Moreover, the conditions of knowledge use also change as a result of these seismic shifts in the research space. Rather than being openly available public or merit goods, knowledge became a commodity subject to private property rights designed to facilitate exclusive commercial exploitation. Nedeva and Boden (2006) note how ‘money spent on universities and their research became not an expense, but an investment, with an expected return in terms of commodified knowledge and expertise’. This is a shift from a gift to a financial economy.

We suggest, although the empirical evidence has yet to be collected, that these transformations in research space have changed the nature of research fields and therefore of the nature of what they put into knowledge pools. Research fields are now shaped and directed by economic and financial imperatives and the demands placed upon them by the commercial users for near-market knowledge. The conditions of knowledge production that they operate within are those of the corporatised and commercialised universities (Epstein et al 2007). Thus, we posit, the nature of knowledge pools will shift towards the bottom right corner of Pasteur’s Quadrant – that which is user led and does not seek fundamental understanding. Whilst there will always be a demand and a real need for such knowledge, many scientists are expressing concern at the loss of deeper level skills and knowledges implicit in such a re-focusing of scientific endeavours.

3 Towards a normative model for knowledge pools

The transformation of knowledge pools in UK science is part of a continuing trend and also one visible in many other countries globally. In the UK the motivation has been that the knowledge produced by universities had been too abstract and not suitable for supporting the needs of the knowledge economy. The recent shifts in the nature of the pools is part of an attempted compression of time and an avoidance of the risk that knowledge might never be useful: in traditional science knowledge put into the pools might be immediately useful, useful in a hundred years time or never of use at all. It was such considerations that led to the initial placement of scientific knowledge production outside the commercial realm. The attempt now is to produce only immediately useful knowledge as only this can be justified financially as likely to provide an appropriate payback on investments made.

We have stated elsewhere that ‘such and similar developments will gradually erode the capacity of universities and academics to generate ‘understanding’ type knowledge, which is their exclusive domain’ (Nedeva and Boden 2006: XXX). Of course, some would not view such developments with alarm and might argue that the market should drive all knowledge production. Accordingly, we would like to develop here an extension

of our 2006 argument that the reshaping of knowledge pools in this way might ultimately be fatally counterproductive for innovation.

In doing so we draw upon recent work that suggests that innovation works best in situations which are quite different from those conceptualised in government strategies. In such strategies innovation processes are often conceived of linear, with knowledge producers filling knowledge pools for subsequent extraction for exploitation by users. Policies that facilitate or incentivise spin-out activities or patenting are symptomatic of such approaches. The shift that has occurred in UK knowledge pools represents nothing more than a tightening and speeding up of this process.

Yet, innovation cannot be this simply conceived of as a supply – push linear knowledge transfer process (Bruland and Mowery, 2005; Brown and Ternmouth, 2005; European Commission, 2006a). Successful innovation increasingly appears to be a networked and reciprocal process involving ongoing relationship amongst a range of stakeholders who share their knowledge (Fagerberg 2005) engaged in ‘open innovation’ practices and processes (Chesborough 2003; Hippel 2005; Brown and Ternmouth, 2005; European Commission, 2006a).

This trend is identified by recent UK reports on innovation practices (e.g. Lambert 2003). But whilst a number of collaborative forms have been tried between firms and UK universities, these have not moved beyond formal knowledge sharing to genuine co-working (Brown and Ternmouth 2005).

Some aspects of the concept of ‘open innovation’ have now started to be deployed as a significant conceptual underpinning of policy recommendations (Hughes, 2003).

Open innovation is highly dependent upon cooperative networking relationships in contrast to the competitive and contractual relationships of the market place (see for example Levene and Stewart 1993). Research indicates the importance of flexibility and fluidity in networks (Powell and Grodal 2005; Pavitt 2005; Mowery and Sampatt 2005; Bruland and Mowery 2005). Networks need to be agile and to shift and change according to needs rather than be fixed and defensive as a result of management and governance characteristics.

This suggests that the best innovative practice to make use of knowledge pools is, increasingly, framed by open and flexible partnerships and by collaborative networks rather than combative competitions. This also suggests that in determining the optimal conditions for knowledge pools we should be building radically new spaces and fields that reflect these practices.

The new fluidity engendered by recent exogenously driven change in UK publicly funded science offers the prospect of the creation of new organisational forms which escape the neoliberal *cul-de-sac* into which UK publicly funded science has been steered. That is, having created the situation in which research fields and spaces have been re-shaped, perhaps they might be re-shaped in more intelligent ways? In particular, it might be possible to build open and collaborative communities around knowledge pools.

Our interrelated shapers of research fields – the conditions that must exist within the research space – were funding, conditions of knowledge production and conditions of use. In open and collaborative pool communities one would expect funding to be joint between the public and private domains and freely given. That is, funding would contribute towards the creation of a commonly owned knowledge pool to which there was free access for exploitation. In terms of conditions of knowledge production, this would be on a collaborative basis rather than a competitive one. Research by Mowery and Sampat (2005) indicates that the existing growing level of interaction between universities and the private sector is associated with changing cultures. The increasing flexibility within universities would assist in this regard. And finally, access to knowledge pools would be free and unfettered, thereby facilitating exploitation as rapidly as possible. Hippel (2005) and Chesborough (2003) raise the importance of collective ownership through creative commons licensing as opposed to more personal and monopoly based versions of intellectual property rights, and the implications this has for value creation, meaning and ownership.

If open innovation practices are to be supported by suitable knowledge pools then it is necessary to give some attention to the forms of governance, ownership and management that would be suitable for the various organisations that might populate such processes. That is, how can knowledge pools be framed and constituted so that they become core to open innovation? It can be assumed that existing forms of governance, ownership and management might not necessarily be suitable, especially if they are predicated on conceptions such as market competition, arms-length relationships and commercial confidentiality – the types of organisational forms that the UK government has promoted for publicly funded science for some years (Boden *et al.* 2004).

We believe that there may be a role here for cooperatives as suitable ownership, governance and managerial vehicles to ‘carry’ the knowledge creation process. Cooperatives have been defined by the International Cooperative Alliance as ‘autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise’ (ICA website). The active participation of members is a particular feature of cooperatives.

Research spaces would be populated by a variety of actors, including private corporations. These actors could coalesce into research fields which would be, naturally, led by universities as primary knowledge producers. The shaping of the field would be carried by a cooperative formal structure in which every participant both contributed resources and could exploit knowledge. The reification of this cooperative relationship might be a research institute.

The advantage of such structures is that they would build ongoing relationships between knowledge producers and users, rather than users rather than treating knowledge producers as a resource to be exploited, like mining diamonds. Users would have an ongoing interest in ensuring that producers developed fundamental understanding-type

knowledge because they would be fearful of short-termism unduly influencing research agendas. Such vehicles would help to build whole communities around and within research fields.

For universities, the advantage of such cooperative working styles is that it would liberate them from being captive to capitalistic short term economic pressures and enable them, working in partnership with knowledge users, to produce research of a fundamental understanding type (along with applied research if so wished). Academic researchers would work in active partnership rather than being the rough end of a linear knowledge extraction 'stick'. Such arrangements might also have the added advantage of driving academic research away from competitive and profit-seeking ways of working and more towards collegial and open forms of science. Arguable, this might help universities recuperate their position as important socio-economic actors producing and gifting public and merit good knowledge in return for reputation and standing.

References:

- Appadurai A (2001) "Grassroots Globalization and the Research Imagination" in Appadurai A. (ed) **Globalization**, Durham and London: Duke University Press
- Arrow, A. 1962. "The Economic Implications of Learning by Doing,." *Review of Economic Studies* 29: 155-73.
- Baskaran A and Boden R (2007) "Prometheus Bound: Accounting and the creation of the new science paradigm", *International Studies in Management and Organisations*. 37, 1, 9-26.
- Boden R, Cox, D and Nedeva M (2006) "The Appliance of Science? – New Public Management and Strategic Change", *Technology Analysis and Strategic Management*, 18,2, 125-41.
- Boden R, Cox D, Nedeva M and Barker K (2004) *Scrutinising Science*, London: Palgrave.
- Böhme G, van den Daele W and Hohlfeld & (1983) 'Finalization Revisited' in Schäfer W and Burgess P (eds) *Finalization in Science: The Social Orientation of Scientific Progress*, Amsterdam: Kluwer Academic Publishers.
- Bonaccorsi A. (2004) "Search Regimes and the Industrial Dynamics of Science", PRIME Annual Conference, December 2004, The University of Manchester;
- Brown, R. and Ternmouth, P. (2005), *International Competitiveness: Business Working with UK Universities*. (London: Council for Industry and Higher Education).
- Bruland, K. and Mowery, D. (2005), *Innovation Through Time*. The Oxford Handbook of Innovation (Oxford: Oxford University Press).
- Chesbrough, H. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, (Boston, Mass.: Harvard Business School Press).
- Dasgupta P and David P (1994) "Towards and New Economics of Science." *Research Policy* 23: 487-521.
- Dean, M. (1999) *Governmentality: Power and Rule in Modern Society*, London: Sage.
- Edgerton D and Hughes K (1987) "The poverty of science: a critical analysis of scientific and industrial policy under Mrs. Thatcher", *Public Administration*, 67, 419-433.
- Epstein D, Boden R, Deem R, Rizvi F and Wright S (eds) (2008) *The World Yearbook of Education 2008: Geographies of Knowledge/Geometries of Power – Higher education in the 21st century*, New York: Routledge.

European Commission (2006a) *Creating an Innovative Europe*. (EU: Brussels)
http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm

Fagerberg, J. (2005), 'Innovation: A Guide to the Literature', in Bruland, K. and Mowery, D. (2005), *Innovation Through Time: The Oxford Handbook of Innovation* (Oxford: Oxford University Press), pp. 1- 26

Hippel, E.V. (2005), *Democratizing Innovations*. (Stanford, Calif.: MIT Press).

Hughes, A. (2003), *Knowledge Transfer, Entrepreneurship and Economic Growth: Some Reflections and Implication for Policy in the Netherlands*, (ESRC Centre for Business Research: University of Cambridge, Working Paper No. 273).

Monbiot, G. 2001. *Captive State*, London:Pan

Nedeva M and Boden R (2006) "Changing Science: The Advent of Neo-liberalism", *Prometheus*. 24,3, 269-81.

Nelson, R. 1959. "The Simple Economics of Basic Scientific Research." *Journal of Political Economy* 67: 297-306.

Rappert B (1995) "Shifting notions of accountability in public and private sector research in the UK", *Science and Public Policy*, 22, 383-390.

Rose N (1996) "Governing 'Advanced' Liberal Democracies", in Barry A, Osborne T and Rose N (eds) *Foucault and Political Reason*, London: UCL Press.

Rose, H. and S. Rose. 1969. *Science and Society*. London: Penguin

Shattock M (2003) *Managing Successful Universities*, Maidenhead: Open University Press.

Stankiewicz, R (2002) "Design Spaces, generic Capabilities and Research Policy", paper prepared for the *Rethinking Science Policy: Analytical Frameworks for Evidence-based Policy* conference, SPRU, University of Sussex, March 21-23

Stokes, D (1997) *Pasteur's Quadrant: Basic Science and Technological Innovation*, Washington, DC: Brookings Institution Press.

Whitley R (2000) *The Intellectual and Social Organisation of the Sciences* (2nd edition), Oxford: Oxford University Press.